11th European Conference on Applied Superconductivity (15-19/9 2013, Genova-Italy)

Effect of strain and magnetic field on the critical current and electric resistance of the joints between HTS coated conductors

K. Konstantopoulou[1], M. Sarazin[2], J. Lloberas[3], X. Granados[2], M. Sanmartí[3], X. Obradors[2], J. Y. Pastor[1]

[1]Departamento de Ciencia de Materiales, E. T. S. I de Caminos, Canales y Puertos, Universidad Politécnica de Madrid, C/Profesor Aranguren s/n, 28040 Madrid, Spain

[2]ICMAB-CSIC, Campus Autónoma de Barcelona, 08193, Bellatera, Barcelona, Spain

[3]IREC-Institut de Recerca en Energie de Catalunya, 08930 Sant Adrià de Besòs Barcelona, Spain

Introduction

In the past several years, REBaCuO coated conductors have been applied in engineering devices and systems such as magnets, fault current limiters, cables or wires. Their performance has been improved significantly, but although a lot of studies have been carried out to achieve long length of sc wires, 2G coated conductors can be fabricated to length of order of 1 Km. Thus, joints techniques are essential in order to produce long tape for application. In this study, non-superconducting joints have been prepared, using a low melting point metal as a soldering material. The mechanical and magnetic characterization of the obtained joints have been performed.

Goal

The effect of the applied load (by axial tensile test) and the external magnetic field to the joint between the stabilizer Cu side of two coated conductors and the calculation of the obtained resistivity, R_s, of the joints for the purpose of qualifying the soldering material and evaluating the soldering process.

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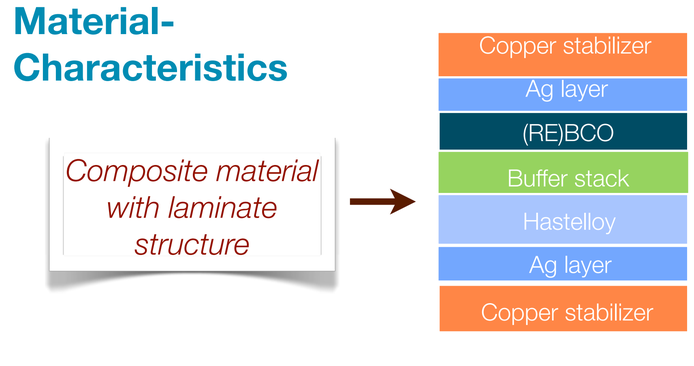
Material-Characteristics

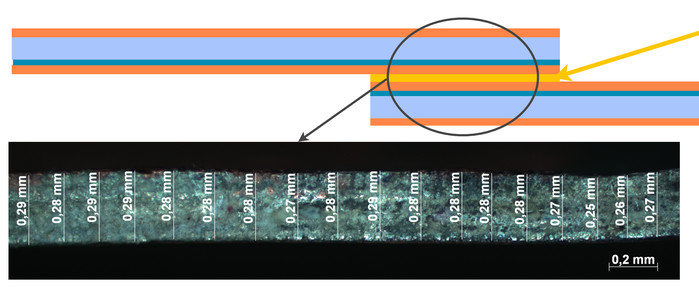
Composite material with laminate structure



Dimensions of the nanostructured cc

Length (mm)	Width (mm)	Thickness (μm)
90	4	90

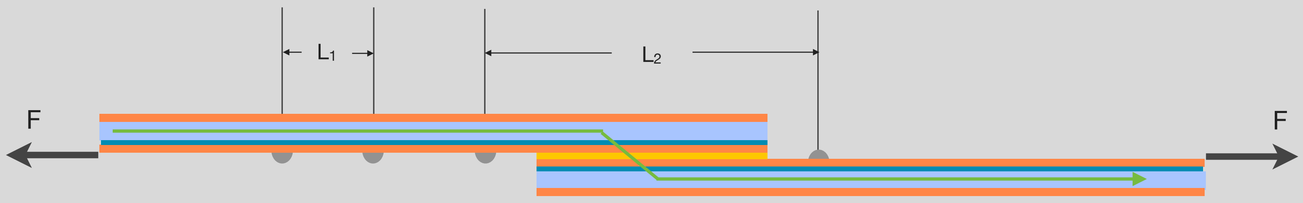
Soldering material:
Sn-Ag-Cu



Joint thickness by optical microscopy

Joints characteristics

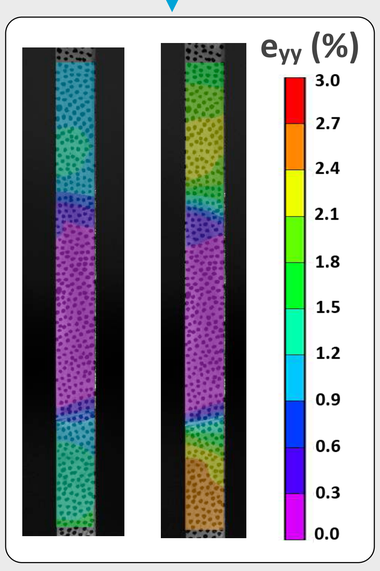
No joints	Thickness (μm)	L (mm)	R (nΩ)	T (ºC)
40	70-100	20	39-58	< 250



Mechanical Characterization

Tensile tests

- Position control
- Actuator speed= 150 μm/min
- Optical-Digital Image Correlation method (300 K) to obtain the complete strain contour on the tape and joint surface.



Magnetic Characterization

Tensile tests

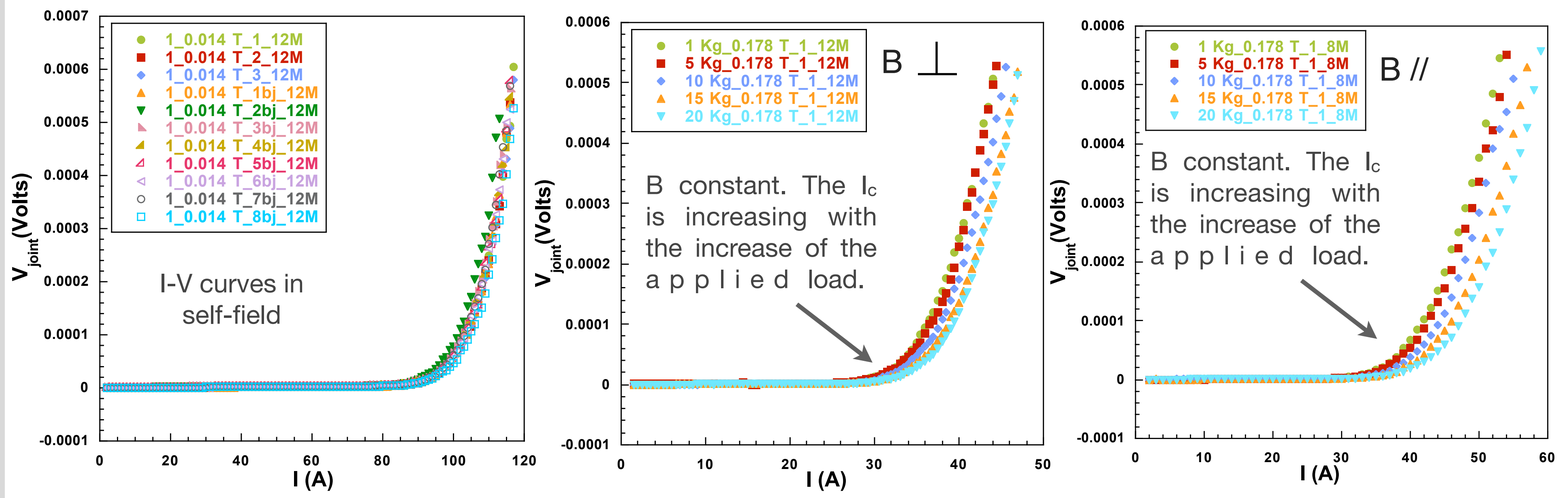
- L_1= 20 mm and L_2= 40 mm
- Applied load F= 10-200 N
- External magnetic field, B, parallel and perpendicular to the tape.

Preliminary numerical study

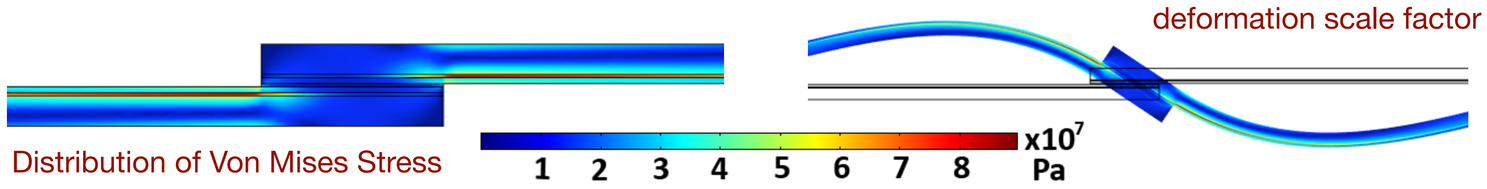
The elastic linear behavior of a sample under tensile test has been studied. Linear elastic materials are used for each layer.

Results

Electromechanical and Magnetic Characterization



Numerical study- Linear behavior

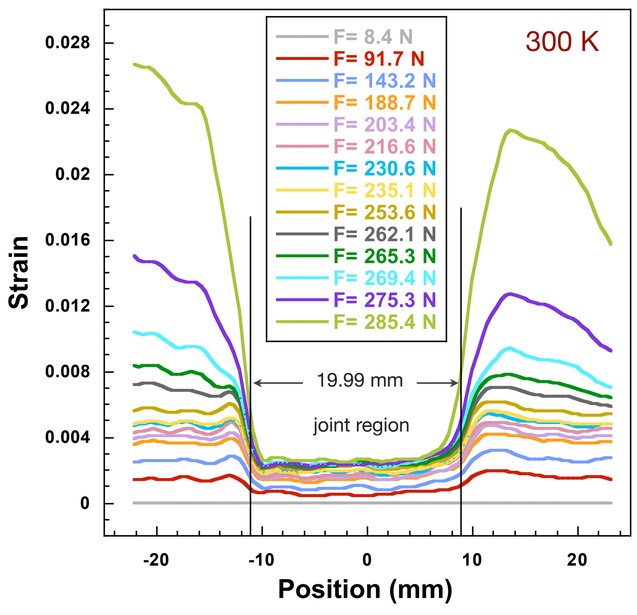


Distribution of Von Mises Stress

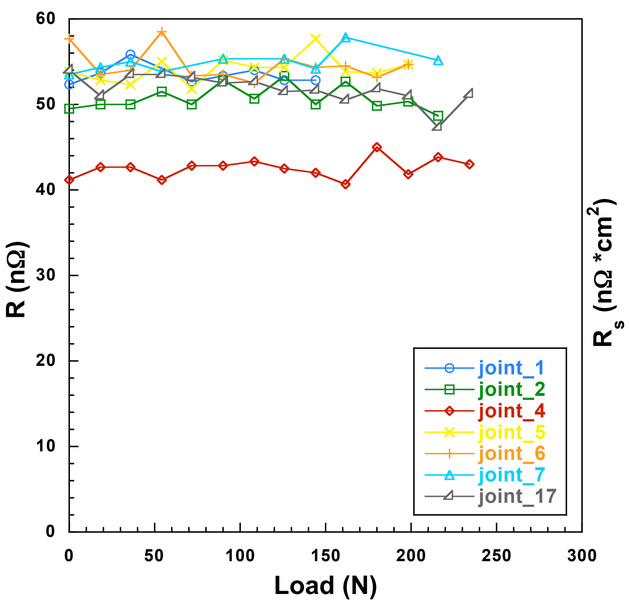
Contour plot of Von Mises Stress with higher deformation scale factor

Results

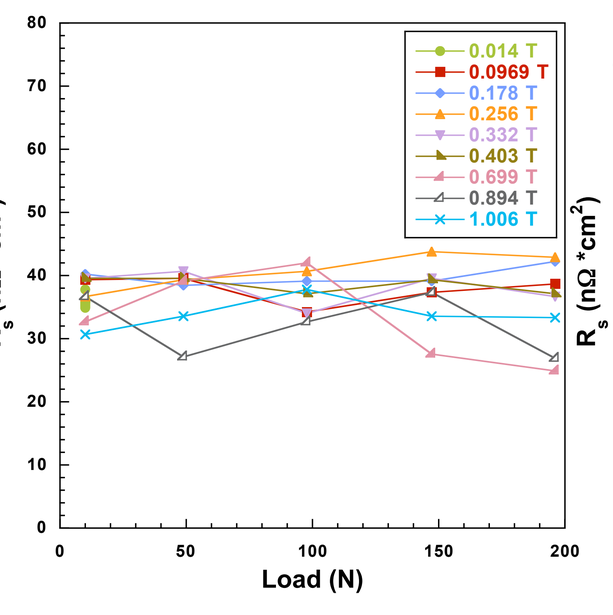
Complete strain contour under tensile test



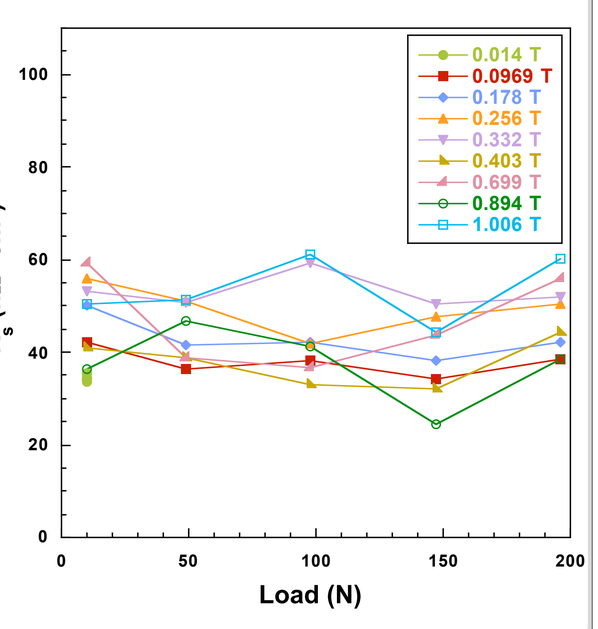
Effect of the applied load on the joint's resistance under tensile test



External B perpendicular to the tape



External B parallel to the tape



Conclusions

- Digital Image Correlation method has been applied to obtain the complete strain contour on the surface of the sample at 300 K. There is no strain concentration on the edges of the joint. The mechanical failure always happened on the tape and not on the joint.
- The dependence and the effect of the applied load have been studied. The R_s and the R of the joint have been obtained and remained almost constant. Small variations are due to the noise introduced by the cables of the experimental setup.
- Tensile tests under the application of external magnetic field parallel or perpendicular to the tape have been carried out. The I-V curves for the joints have been obtained. I_c is decreasing significantly due to the increase of B. However, for a constant B, a slight increase of I_c has been observed with the increase of the applied load. There was no significant effect of B on the R_s.
- A preliminary numerical study of the linear behavior of the joint under tensile test has been performed. The distribution of the stress on the different layers of the sample has been represented.

Acknowledgements

We acknowledge the financial support from MICINN (consolider NANOSELECT, CSD2007-00041,MAT 2011-28874-C02-01), FPI (BES-2010-038562) and EU (EUROTAPES, FP7/2007-2013),MINECO (INNPACTO, IPT-2011-1090-920000,ECCOFLOW EU GRANTS OF 7th FRAMEWORK PROGRAM, EFDA WPI-DAS-01-T11 and WP13).